The Cowrie *Mauritia eglantina* (Duclos, 1833) in Fiji

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(1 Map)

Mr. Walter O. Cernohorsky, Vatukoula, Fiji, was so kind to send us, since 1961, about 2500 cowries collected by himself on the reefs surrounding Vitilevu, the largest island in the Fiji Islands. Most shells contained the animals well preserved in alcohol so that we could ascertain the sex of adult specimens and study the features of the radula.

Mauritia (*Arabica*) *eglantina* (Duclos, 1833) is the most frequent species in these collections, represented by 647 specimens, 548 of which are adult with the sex well recognizable. This great number justifies a special study of variation by statistical methods.

Our map shows the exact place of 12 localities from which Mr. Cernohorsky has sent us satisfying numbers of cowries. In Table 1 these 12 localities have been listed in a counter-clockwise sequence, beginning with the east coast of the island of Vitilevu and ending with the small island of Vatulele about 20 miles off its south coast.

We did not think it necessary to publish the sum of each frequency distribution, nor the standard error of each mean, though we have calculated these figures. In discussing the mathematical significance of differences we have indicated the index t, which expresses the difference divided by its mean error, so that in our large populations

$t > 2.0$ indicates $P < 0.05$
$t > 2.6$ indicates $P < 0.01$
$t > 3.0$ indicates $P < 0.0027$
$t > 3.4$ indicates $P < 0.001$

(see Bancroft, 1959. p. 174); differences with $t > 3.0$ should be regarded as absolutely significant.

Table 1

column number	1	2	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
indicating	sp.	%	%	♀	♂	♀%	L	L%	BL	LT	CT	col.	mar.	spi.	pen.	rows	med.
E Lodoni	50	19	19	23	25	48	49.2	97	58.5	*u*.5	*t*.5	3.5	3.7	4.5	51.4	12.0	8.2
N Vitilevu Bay	132	35		62	50	55	44.2	87	59.0	*u*.1	*t*.3	3.3	3.9	4.2	54.2	12.0	8.1
Nananu-i-ra	90	37		44	40	52	50.4	99	59.1	*u*.2	*t*.5	3.1	3.5	4.3	50.6	12.6	8.2
Caboni (No. 2)	17	31	36	9	3		55.4	109	58.9	*u*.7	*t*.4	3.3	3.7	4.6	(50.0)	(11.5)	(8.0)
Manava Island	18	14		5	11		56.1	110	58.4	*u*.5	*t*.9	3.2	3.3	3.6	54.4	12.3	8.1
Vatia Wharf	191	44		81	67	55	57.1	112	58.5	*u*.5	*t*.7	3.2	3.2	4.5	47.7	11.7	7.8
Twin Rocks	11	37		5	6		49.1	96	59.2	*u*.7	*t*.5	3.2	3.5	4.8	(49.2)	(11.1)	8.2
W Vuda Point	91	19	20	47	29	62	47.5	93	58.8	*u*.9	*u*.0	3.4	3.2	4.5	45.2	12.5	7.8
Momi	10	33		5	5		48.1	94	60.1	*u*.4	*t*.1	4.0	2.9	3.9	(58.0)	12.1	8.4
S Cuvu	28	17		10	15		51.8	102	58.6	*u*.1	*t*.2	3.3	3.0	3.3	42.7	12.2	7.0
St. Annes-on-the-Sea	6	3	8	4	2		(55.0)	108	(58.5)	(*u*.0)	(*u*.2)	3.3	(3.0)	4.8	(57.7)	(11.8)	(8.0)
Lomalagi	—	0		—	—	—	—	—	—	—	—	—	—	—	—	—	—
Vatulele Island	3	14		—	—	—	(47.3)	93	(58.0)	(*t*.4)	(*r*.3)	(4.0)	(2.3)	4.0	—	—	—
Total	647	26		295	253	54	50.9	100	58.7	*u*.4	*t*.6	3.3	3.5	4.3	50.1	12.1	8.0

DISTRIBUTION AND FREQUENCY

Mauritia eglantina spreads from the Ryukyu Islands and North West Australia to Samoa so that it reaches in Fiji almost its eastern limit. Nevertheless it is the most frequent species collected in Vitilevu, as it represents about one quarter of the cowries sent us by Mr. Cernohorsky. In various localities, however, the relative frequency of *M.*

eglantina is very different, varying from total absence in Lomalagi (among 89 cowries) to almost one half of all cowries (Vatia Wharf).

This fact has been illustrated by columns 1 and 2 of Table 1: column 1 gives the number of *Mauritia eglantina* present in each population, whereas column 2 expresses this in per cent of the sum of all cowries we have received from the locality.
Sixten Bock in 1917).

The centre of abundance of *Mauritia eglantina* evidently lies on the north coast of Vitilevu, where the environments of Vatia Wharf seem to be most favorable for this species; on the east and west coasts its frequency decreases, and on the south coast *M. eglantina* generally is less than a quarter as frequent as on the north coast, though it occurs around the entire island (Namuka, *leg.*

SEX

In Table 1, columns 3 and 4 indicate the number of female and male specimens respectively; the difference between the sum of the two sexes and the figure given in column 1 is due to young animals and empty shells. Column 5 expresses the number of females in per cent of the sum of both sexes; in populations containing too few *Mauritia eglantina* to yield a statistically reliable figure, the percentage of females (easily calculated) has been replaced by a point. The number of females slightly exceeds that of males, as we noted before in other cowrie species; only the population of Lodoni seems to be contradictory.

SIZE

The length of the shells has been measured in tenths of a millimeter; the mean length of adult shells (those of unknown sex included) has been indicated in column 6 of Table 1.

A rather large difference between the means of several populations is noteworthy: in fact the difference between Vitilevu Bay and Vuda Point, between Nananu-i-ra and Vatia Wharf, and between Vitilevu Bay and Vatia Wharf are mathematically significant ($P < 0.001$) as the index t is 6.6, 12.4, and even 28.3, respectively; several other differences, however, cannot be proved statistically. Similar differences in size have also been reported for other cowrie species from Fiji by ourselves as well as by Cernohorsky (1963) who suggests them to be caused by food supply. Additionally, there seems to exist also a general tendency of growing large in some regions: column 7, which contains the means expressed in per cent of the total mean 50.9 mm, shows that the populations of *Mauritia eglantina* living in the north east of Vitilevu and along its west coast are small, while those living on the south coast and particularly in the north western localities exceed the average size: these facts may possibly be an indication that currents are also responsible for the differences in size. Specimens from reefs far off the coast of Vitilevu do not differ constantly from those living at the coasts themselves: *M. eglantina* from Vatulele Island is small, that from Manava Island is large.

The variation in size within each population is rather large; we limit ourselves to indicate the variation of the four most numerous populations in classes of 5 mm (c. g. 40 = 38 to 42 mm):

millimeters:	40	45	50	55	60	65	70	75
Vitilevu Bay	43	71	15	3	—	—	—	—
Nananu-i-ra	—	21	48	18	2	1	—	—
Vatia Wharf	—	—	30	72	72	13	3	1
Vuda Point	10	40	27	14	—	—	—	—
Total	59	159	175	143	92	15	3	1
including:								
females	24	67	82	73	42	6	1	—
males	27	72	70	48	31	5	—	—

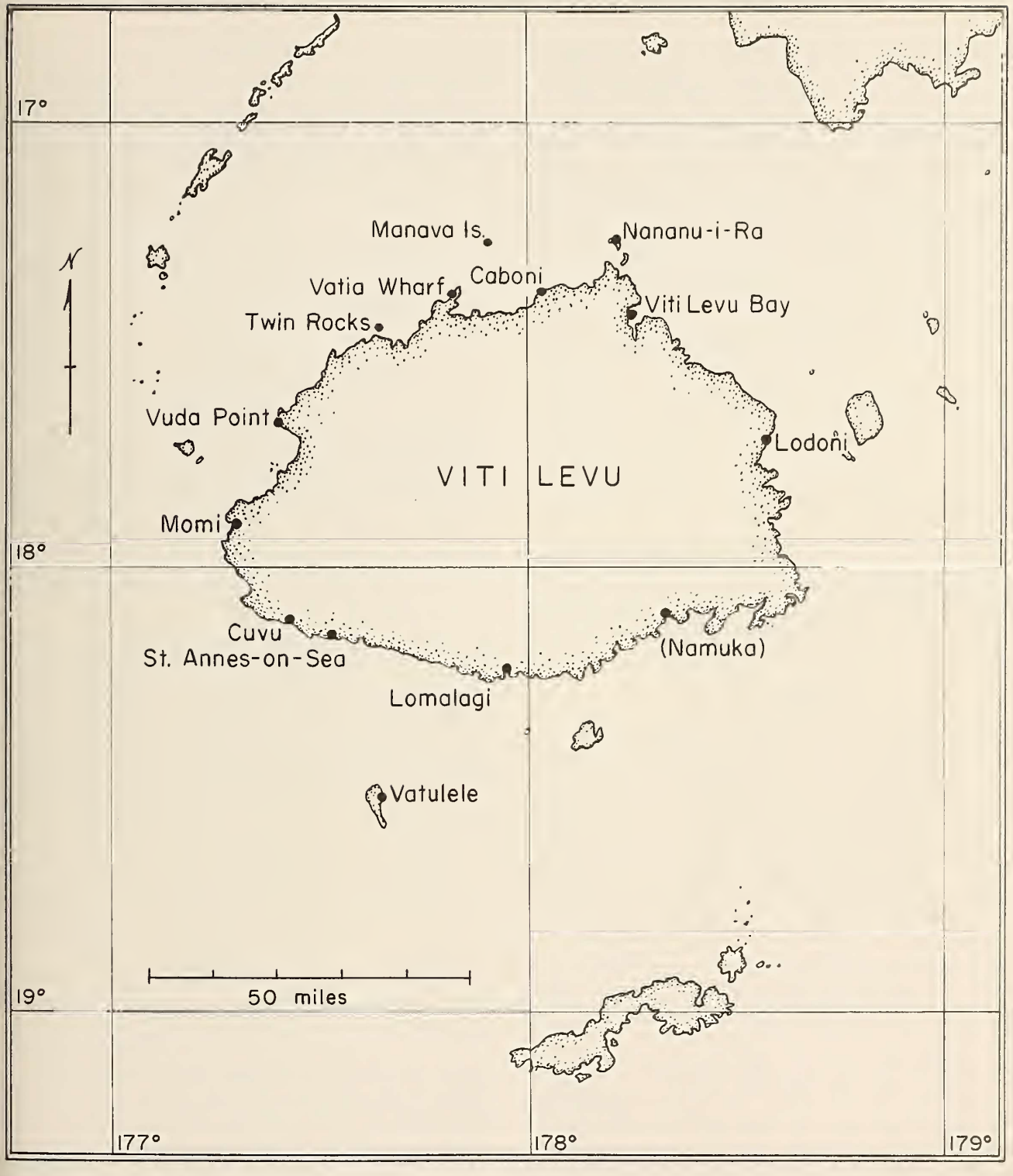
The two lowermost lines indicate that there is a slight difference in size between the sexes: as in most cowries, the females are slightly larger than the males, the difference between the means (51.06 and 50.05) is, however, not significant ($t = 1.9$); in these four large populations the value of t varies only between 0.8 and 2.1, but the females are always the larger sex.

BREADTH

The relative breadth, expressed in per cent of the length, has been indicated in column 8 of Table 1. The differences between populations are rather small, though the shells from Manava Island and from Vatia Wharf are rather narrow, those from Momi rather broad: this fact may be influenced by the length of the shells, as in cowries generally large specimens tend to be less broad than small shells. The total variation of relative breadth in 627 adult shells is rather small, so that the general appearance of *Mauritia eglantina* is fairly uniform; the difference of sexes, however, is obvious:

relative breadth:	53	54	55	56	57	58	59	60	61	62	63	64	65
Total	1	9	15	43	92	115	135	101	77	29	8	1	1
including:													
♀ ♀	—	2	4	13	26	44	65	63	52	19	5	1	1
♂ ♂	1	6	10	27	53	61	49	27	14	5	—	—	—

The difference between the mean of females (59.3) and that of males (58.0) is significant ($t = 9.2$), as are the differences also in the three largest populations ($t =$ 3.5 to 5.3).


17°
Manava Is.
Nananu-i-Ra
Vatia Wharf
Caboni
Viti Levu Bay
Twin Rocks
N
Vuda Point
Lodoni
VITI LEVU
Momi
18°
Cuvu
St. Annes-on-Sea
(Namuka)
Lomalagi
Vatulele
50 miles
19°
177°
178°
179°

DENTITION

The relative closeness of labial teeth (LT) and of columellar teeth (CT) has been recorded in column 9 and 10 of Table 1, respectively, by letters with decimal figures according to SCHILDER, 1958; there is no significant difference between populations. The total variation and that of sexes is as follows:

class:	*p*	*q*	*r*	*s*	*t*	*u*	*v*	*w*	*x*	*y*	*z*
Total: LT	—	2	7	21	125	173	207	80	26	2	2
Total: CT	1	10	37	103	154	166	104	59	9	1	1
LT: ♀ ♀	—	1	2	10	56	82	99	34	9	—	2
LT: ♂ ♂	—	1	3	7	50	71	75	35	10	1	—
CT: ♀ ♀	—	4	11	46	67	81	53	30	2	—	1
CT: ♂ ♂	1	4	19	43	71	56	34	18	6	1	—

The teeth of both lips are rather identical in closeness, as the mean of each lip is about *u* (*u*.41, *t*.60). The sexes, however, show a curious discrepancy: the closeness of labial teeth is absolutely identical in both sexes (mean = *u*.40), but the columellar teeth of females (*t*.72) are distinctly closer than those of males (*t*.47), though the difference hardly can be called significant ($t = 2.0$).

COLOR

The color of the dorsal markings has been classified in six degrees (see SCHILDER, 1964, table 2): 1 = pale fulvous; 2 = fulvous; 3 = fulvous brown; 4 = chestnut; 5 = dark brown; 6 = blackish. The variation is rather slight, as the Fijian specimens vary from class 2 to class 4 only, and the means of populations vary from 3.1 to 4.0, according to column 11 of Table 1. The total and sexual variation are as follows:

class	1	2	3	4	5	6	Mean
Total	—	81	333	157	44	—	3.3
including:							
females	—	38	153	78	21	—	3.3
males	—	33	144	58	15	—	3.2

Generally, paler shells (class 2 to 3) are slightly more frequent than darker ones. There is no sexual difference in this character.

The color of the base varies from yellowish or pinkish white to dark greyish brown or bluish grey; the frequent differences between the two lips and the multiplicity of tints make a statistical treatment of this character almost impossible.

DORSAL MARKINGS

In adult *Mauritia eglantina* the dorsum is covered by brown longitudinal lines which become interrupted by roundish lacunae; in these lacunae the transversal zones and the zigzag lines of young shells are still better visible than between the longitudinal striae. According to SCHILDER *et al.*, 1964 (Table 2), we have distinguished six classes: 1 = lacunae almost absent so that the dorsum is striate; 2 = lacunae scarce; 3 = lacunae less scarce, but striae still slightly predominant; 4 = the areas covered by lacunae are about equal to the striate areas; 5 = lacunae more numerous or larger; 6 = lacunae predominant, striae reduced and often dilacerate. According to column 12 of Table 1 the populations are similar to each other, except the ten shells from Momi in which the striae are more predominant than in other populations. The total and the sexual variation are as follows:

class	1	2	3	4	5	6	Mean
Total	44	173	41	238	36	80	3.47
including:							
females	23	72	24	111	21	37	3.51
males	15	74	13	103	12	31	3.47

The constant irregularity in these distributions of frequency has been caused by using the main classes 2, 4, and 6 more frequently than the intermediate classes 3 and 5. In our *Mauritia eglantina* the striae occupy a slightly larger area than the lacunae; the sexual difference must be regarded as accidental ($t = 0.3$).

SPIRE BLOTCH

In *Mauritia eglantina* there is a dark brown blotch on the labial border of the spire; it is said to be characteristic for this species as it is in *M. histrio* (GMELIN, 1791), *M. mappa* (LINNAEUS, 1758), and *M. grayana* SCHILDER, 1930, while it is always absent in other allied *Mauritia*, viz. *M. arabica* (LINNAEUS, 1758), *M. maculifera* SCHILDER, 1932, *M. depressa* (GRAY, 1824), and *M. scurra* (GMELIN, 1791). The size of this blotch has been classified in six degrees (according to SCHILDER, 1964, Table 2): 1 = absent; 2 = obsolete; 3 = small; 4 = rather large; 5 = typically large; 6 = extremely large. Column 13 of Table 1 shows the differences of populations; the total and the sexual variation are as follows:

class	1	2	3	4	5	6	Mean
Total	12	21	79	182	277	47	4.35
including							
females	3	8	37	87	130	24	4.40
males	7	8	28	73	117	17	4.34

The most frequent class is 5 ("normal") in both sexes, though the mean tends towards the class 4 on account of the five per cent of adult shells in which the spire blotch is absent or obsolete.

SHELL ABNORMALITIES

Among the 647 *Mauritia eglantina* from Fiji there are two slightly subrostrate shells (Vitilevu Bay, Vuda Point) and one rather melanistic female (Momi), but no truly melanistic rostrate shell has been sent us by Mr. Cernohorsky from Fiji, whereas such shells are rather frequent in New Caledonia. One male from Nananu-i-ra is rather pellucid in texture. Four shells are pathologically suffused by green enamel, and one shell by greyish enamel, each from different localities. Besides, particles of mud are enclosed in the dorsal enamel, or forming whitish tiny holes in the surface of at least 25 specimens from 6 localities, chiefly from Vatia Wharf and from Lodoni: 20 such specimens are females which number far exceeds the probability of random distribution. In one male from Vatia Wharf the dorsum is much worn like in beach shells though the animal was living when collected; three live specimens show the juvenile zigzag markings uncovered though the lateral and basal callosities are at least as developed as in other adult shells. One female from Vitilevu Bay shows a dark blotch on the inner lip, comparable to that of *M. maculifera* SCHILDER. In many shells there are the usual holes, traces of bites, or fractures suffered in juvenile stages, all wounds healed during the animal's later life; one shell from Vuda Point shows the columellar margin inflated, though to a lesser degree than figured by SCHILDER, 1936, figure 3.

YOUNG SHELLS

Among the 647 shells sent by Mr. Cernohorsky, 26 are not fully grown (i. e. 4 per cent); following SCHILDER (1938, page 123) they should be classified as: 7 subjunior, 4 junior, 14 juvenis and 1 perjuvenis. Besides there are 4 oliviform shells not included in the total mentioned above.

PENIS

The length of the penis, expressed in per cent of the length of the shell, varies from about 20 to 85 per cent in 240 specimens, as follows:

%	20	25	30	35	40	45	50	55	60	65	70	75	80	85
♂♂	2	—	6	11	30	54	60	28	20	17	2	6	2	2

This surprisingly considerable variation may be caused partially by different erection of the penis at the moment of the death of the animal in alcohol, partially by different times elapsing between collecting, preserving, and examining the specimens. The mean, however, undoubtedly is 50.1 per cent of the shell length; the local differences of means are relatively small (see column 14, Table 1).

ROWS OF THE RADULA

According to SCHILDER, 1960 and 1961, the number of rows of the radula has been expressed in dozens (e. g. 5 = 54 to 66 rows); it is evidently independent from the size of the shell. The range of variation is rather large, ranging from 5 to 21 dozens (the single specimen with 21 dozen rows may be pathological):

dozens	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Total	1	2	5	6	9	35	90	124	102	52	15	4	1	—	—	—	1
including:																	
females	1	—	3	2	4	7	25	61	71	46	12	4	1	—	—	—	1
males	—	2	2	4	5	28	65	63	31	6	3	—	—	—	—	—	—

But according to column 15 of Table 1, the means of populations vary rather little around the total mean of 12.06 (i. e. exactly 145 rows), viz. from 11.7 to 12.6 dozens (if one omits the figures put in brackets as these populations include less than ten complete radulae); however, the difference between the two extremes (Vatia Wharf and Nananu-i-ra) should be regarded as significant ($t = 3.4$).

The females possess more rows than the males, as the difference between the total means (12.67 and 11.46) is very significant ($t = 8.2$), and it is also mostly significant in each large population, viz.:

mean of	females	males	t
Vitilevu Bay	12.24	11.59	2.0
Nananu-i-ra	13.45	11.59	5.5
Vatia Wharf	12.17	11.19	3.1
Vuda Point	12.91	11.68	3.2

MEDIAN TOOTH

The relative size of the median tooth of the radula has been expressed, as in previous papers (SCHILDER, 1960) by an index representing 200 times the maximum transverse diameter of the median tooth, divided by the length of the shell. The variation of this index is as follows:

index	4	5	6	7	8	9	10	11
Total	1	8	24	158	185	92	48	9
including:								
females	—	1	19	137	112	12	—	—
males	1	5	5	21	73	80	48	9

The local means (column 16, Table 1) generally approach the total mean (7.96) rather closely so that the differences between the populations are mostly not signi-